

MODERN PHYSICS II

- **Instructor:** Dr. Igor Ostrovskii

➤ **Course objectives:**

1. Introduce the physics major graduate students to 20-th century physics;
2. Advance an understanding of the ideas of quantum physics;
3. Expand an awareness of the current basis of knowledge in physics including quantum statistics, properties of solids, and basic properties of nuclei and particles;
4. Discuss the problems confronting physics in the 21-st century.

- ❖ **Lecture:** TTh 11:00 – 12:15, Room 126 Lewis Hall
- ❖ **Office:** Room 207 Lewis Hall, Tel: 915-1536; Email: iostrov@phy.olemiss.edu
- ❖ **Office Hours:** MWF 2:30 – 3:30 p.m. (207 Lewis Hall)

Texts*:

- 1) [K]: Introduction To Solid State Physics, by Charles **Kittel**, 7-th edition, 1996.
- 2) [L]: Principles of Modern Physics, by Robert B. **Leighton**, McGraw-Hill Book Company.
- 3) [M]: Condensed Matter Physics, by Michael P. **Marder**, John Wiley & Sons, 2000.

* - Textbooks [K, L] are for main reading and [M] is recommended for additional reading.

- **Grading Scale:** A's ----- 90 – 100
B's ----- 80 – 89, etc.

Grades will be based on homework, tests, and the final examination:

Homework ----- 20%
Three tests ----- 45% (#1=15%, #2=15%, #3=15%)
Final examination ----- 35%

➤ **Tests and Final examination schedule:**

- **Test 1 (Quantum Statistics, Electrons and Phonons in Solids):**
Chapters 4, 5, 6-A [K] & Ch. 10 [L] ----- Tuesday, February 10.
- **Test 2 (Properties of Solid State):**
Chapters 6-B, 7, 8 [K] ----- Thursday, March 25.
- **Test 3 (Crystal Defects, and Basic Properties of Nuclei)**
Chapters 11, 18 [K]; 13, 15, 16 [L] ---- ----- Tuesday, April 27.

❖ **FINAL EXAMINATION ----- Tuesday, May 4, 4 p.m.**

- **Homework Rules:**
 1. Homework is assigned after some sections are covered and is due in a week.
 2. Homework paper should be 8.5 x 11 inches with no torn or tattered edges. Homework papers should be stapled.
 3. Show all your work; the answer alone is not worth anything. Homework problems must include enough English to be understandable.
 4. **Important: Circle the finale answers that you want to be graded.**

SYLLABUS

1. **QUANTUM STATISTICS [K: Appendix D; L: Ch. 10]:** {3 classes}
Three quantum distribution laws. Applications of the Maxwell-Boltzmann, Fermi-Dirac and Einstein-Bose distribution laws.

2. PHONONS I: CRYSTAL VIBRATIONS [K: Ch.4]: {2 classes}

Vibrations of crystals with monatomic basis, two atoms per primitive basis,
Quantization of elastic waves, Phonon momentum, Inelastic scattering by phonons.

3. PHONONS II: THERMAL PROPERTIES [K: Ch.5]: {2 classes}

Phonon heat capacity, Anharmonic crystal interactions, Thermal conductivity

4. FREE ELECTRON FERMI GAS I [K: Ch.6-A] {2 classes}

Energy levels in one dimension, Effect of temperature on the Fermi-Dirac distribution,
Free electron gas in three dimensions, Heat capacity of the electron gas.

➤ **TEST #1 (Class 10), L: Ch. 10; K: Chas. 4, 5, 6-A → Tuesday, February 10**

5. FREE ELECTRON FERMI GAS II [K: Ch.6-B] {2 classes}

Electrical conductivity and Ohm's law, Motion in magnetic fields,
Thermal conductivity of metals, Nanostructures.

6. ENERGY BANDS [K: Ch. 7] {3 classes}

Nearly free electron model, Bloch functions, Kronig-Penney model, Wave equations of electron in a periodic potential, Number of orbitals in a band.

7. SEMICONDUCTOR CRYSTALS [K: Ch. 8] {4 classes}

Band gap, Equations of motion, Intrinsic carrier concentration, Impurity conductivity,
Thermoelectric effects, Semimetals, Superlattices.

➤ **TEST #2 (Class 21) K: Chas. 6-B, 7, 8 → Thursday, March 25**

8. OPTICAL PROCESSES AND EXCITONS [K: Ch. 11] {3 classes}

Optical reflectance, Excitons, Raman Effect in crystals,
Energy loss of fast particles in a solid.

9. POINT DEFECTS IN SOLIDS [K: Ch. 18] {3 classes}

Lattice vacancies, Diffusion, Color centers.

10. BASIC PROPERTIES OF NUCLEI [L: Chas. 13, 15, 16] {2 classes}

Charge and Mass, Angular momentum, Magnetic momentum, Nuclear magnetic resonance,
Radioactivity, Nuclear structure, Nuclear reactions; Nuclear models; Nuclear forces, The meson theory of nuclear forces.

➤ **TEST #3 (Class 29) K: Chas. 11, 18; L: Chas. 13, 15, 16 → Tuesday, April 27**

11. PARTICLES (REVIEW) [L: Ch. 20] {1 class}

Electrons and positrons, Photons, Protons, Neutrons, Neutrinos, Muons, Pions,
K-mesons, Hyperons, Theoretical interpretation of particle properties.

❖ **FINAL EXAMINATION ----- Tuesday, May 4, 4 p.m.**

* - The dates of three tests are tentative, and may be changed.